Chapter 1

Fundamentals of electrical machines

Transformers

Transformer

Is a device that changes AC electrical power at one level of voltage and current into AC electrical power at another level of voltage and current through the action of magnetic field, **without a change in frequency.**

The transformer is probably one of the most useful electrical devices ever invented. It can change the magnitude of alternating voltage or current from one value to another. This useful property of transformer is mainly responsible for the widespread use of alternating currents rather than direct currents i.e., electric power is **generated, transmitted and distributed** in the form of alternating current. Transformers have **no moving parts, rugged and durable in construction**, thus requiring very little attention. They also have a **very high efficiency**—as high as 99%. In this chapter, we shall study some of the basic properties of transformers.

- # Transformer
- **A transformer is a static piece of equipment used either for raising or lowering the voltage of an a.c. supply with a corresponding decrease or increase in current.** It essentially consists of two windings, **the primary and secondary**, wound **on a common laminated magnetic core** as shown in Fig. (1).
- **The winding connected to the a.c. source is called primary winding (or primary)** and the **one connected to load is called secondary winding (or secondary).**
- The alternating voltage V_1 whose magnitude is to be changed is applied to the primary.
- Depending upon the number of turns of the primary (N_1) and secondary (N_2), an alternating e.m.f. E_2 is induced in the secondary.
- This induced e.m.f. E_2 in the secondary causes a secondary current I_2. Consequently, terminal voltage V_2 will appear across the load.
- If **$V_2 > V_1$**, it is called a **step up-transformer**. On the other hand, if **$V_2 < V_1$**, it is called a **step-down transformer.**

Star- Star connection

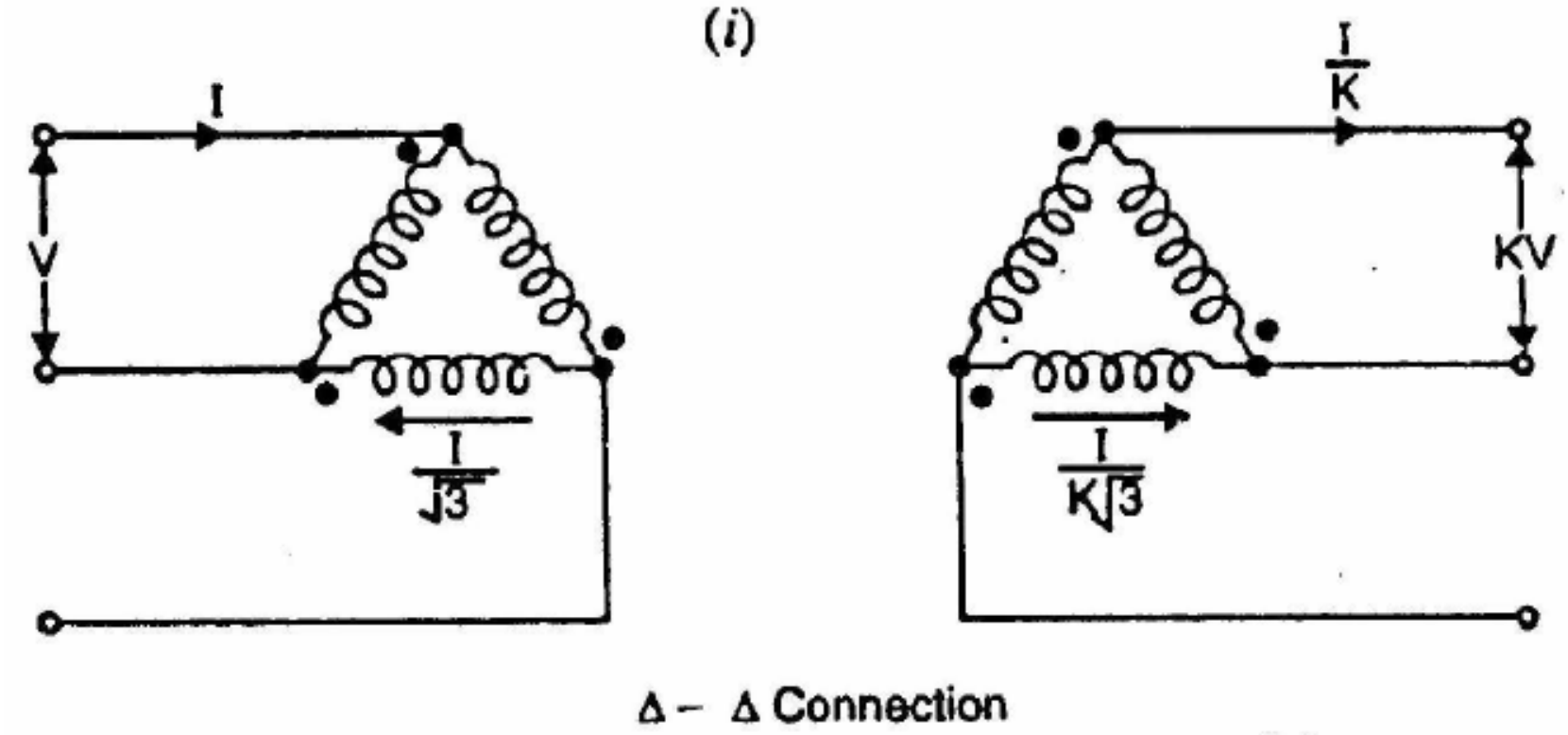
Disadvantages

1.If the load on the secondary side unbalanced then the shifting of neutral point is possible

2.The third harmonic present in the alternator voltage may appear on the secondary side. This causes distortion in the secondary phase voltages.

3. Magnetizing current of transformer has 3^{rd} harmonic component

Delta - Delta connection



Δ – Δ Connection

- **This connection is used for moderate voltages**

Delta - Delta connection

Advantages

1. System voltages are more stable in relation to unbalanced load
2. If one phase is failed it may be used for low power level i.e. V-V connection
3. No distortion of flux i.e. 3^{rd} harmonic current not flowing to the line wire

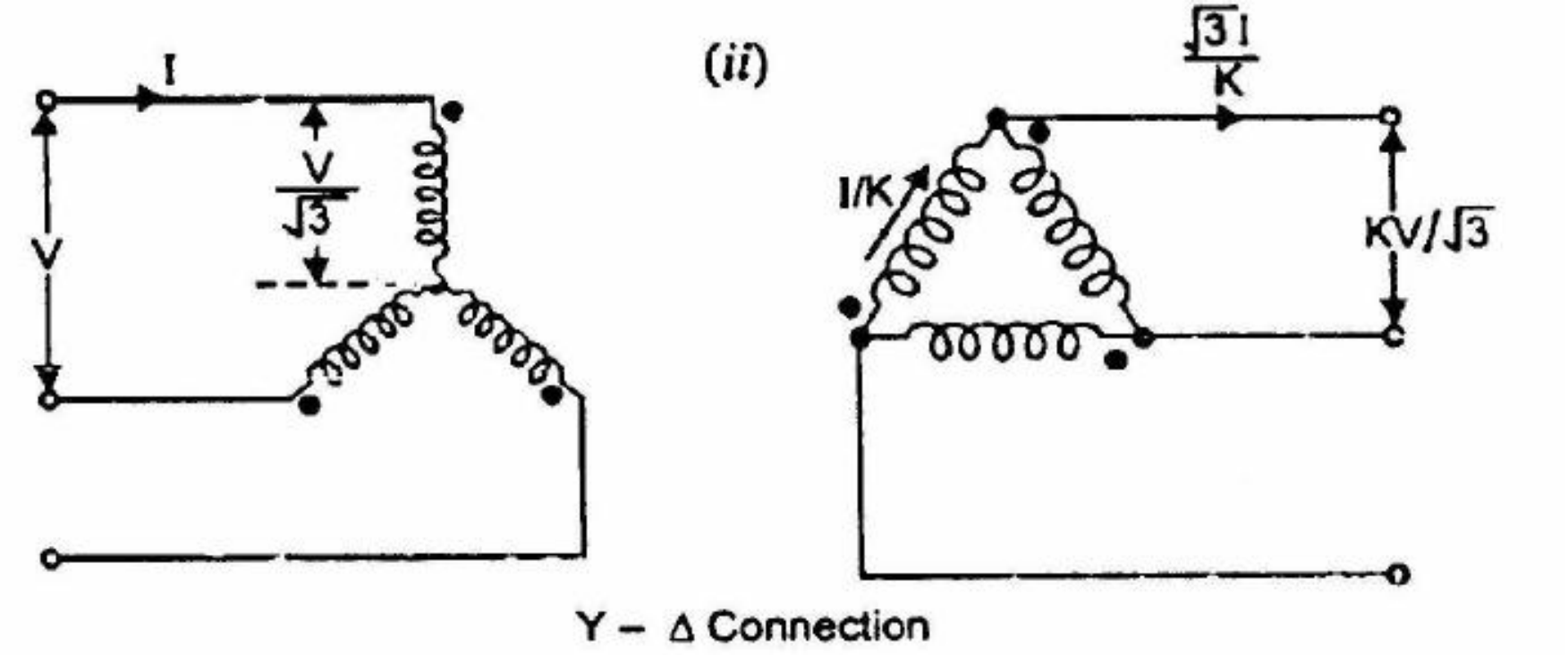
Delta - Delta connection

Disadvantages

1. **Compare to Y-Y require more insulation.**

2. **Absence of star point i.e. fault may severe**

Star- Delta connection



Y – Δ Connection

- **Used to step down voltage i.e. end of transmission line**

Star- Delta connection

Advantages

1. The primary side is star connected. Hence fewer number of turns are required. This makes the connection economical

2. The neutral available on the primary can be earthed to avoid distortion.

3. Large unbalanced loads can be handled satisfactory.

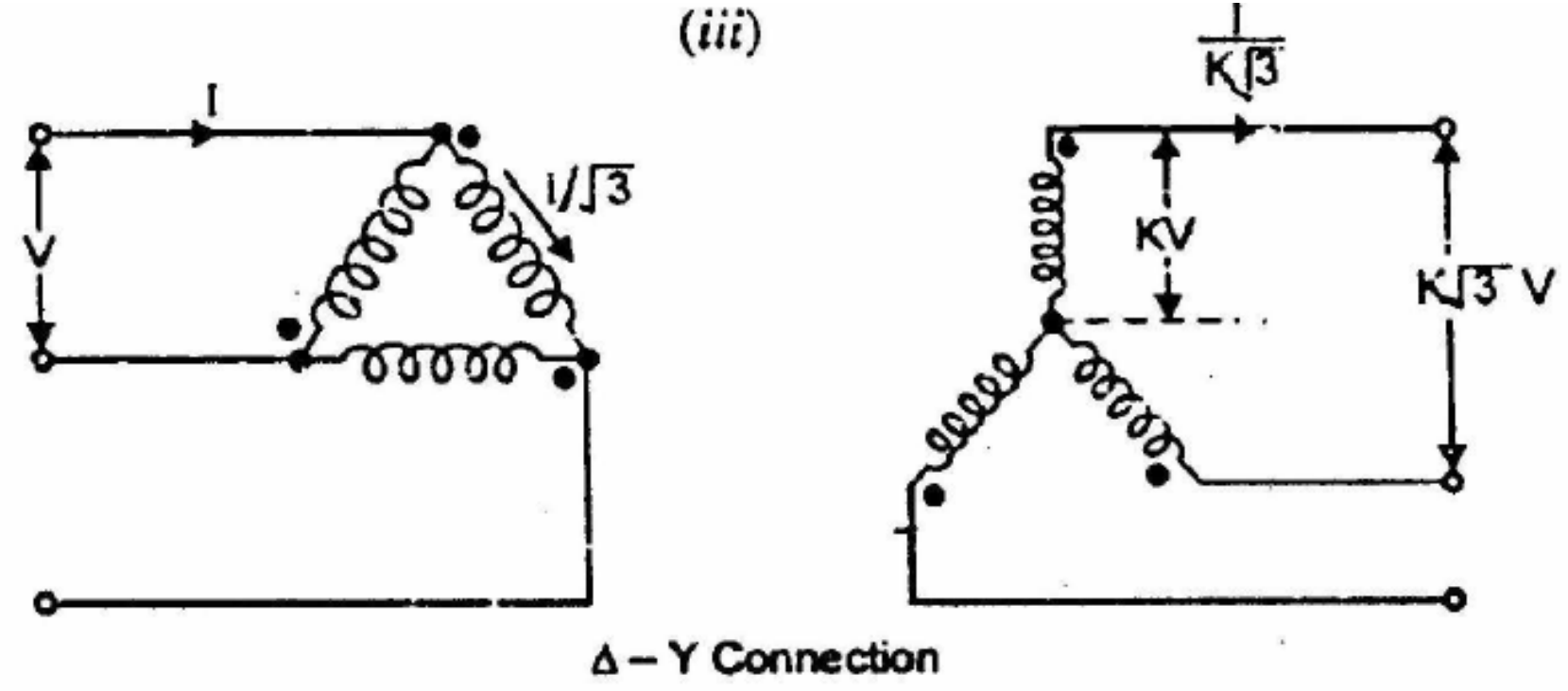
Star- Delta connection

Disadvantages

The secondary voltage is not in phase with the primary. (30 ^{o} phase difference)

Hence it is not possible to operate this connection in parallel with star-star or delta-delta connected transformer.

Delta - Star connection



- **This connection is used to step up voltage i.e. Beginning of high tension line**

Delta - Star connection

Features

- secondary Phase voltage is 1/√3 times of line voltage
- neutral in secondary can be grounded for 3 phase 4 wire system
- Neutral shifting and 3^{rd} harmonics are there.
- Phase shift of 30^{o} between secondary and primary currents and voltages